National Library of Canada
Canadian Theses Service

Ottawa, Canada
K1A 0N4

Bibliothèque nationale du Canada
Service des thèses canadiennes

NOTICE

The quality of this microform is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Reproduction in full or in part of this microform is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30, and subsequent amendments.

AVIS

La qualité de cette microforme dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

La reproduction, même partielle, de cette microforme est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30, et ses amendements subséquents.

NL-339 (r. 88/04) c

Canada

THE UNIVERSITY OF ALBERTA

Testing for Bias in the Canola Futures Market

by

Wayne G. Tymchuk

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Science

IN

Agricultural Economics

Department of Rural Economy

EDMONTON, ALBERTA

Fall, 1990

National Library of Canada
Bibliothèque nationale du Canada

Canadian Theses Service
Service des thèses canadiennes

Ottawa, Canada
K1A 0N4

The author has granted an irrevocable non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of his/her thesis by any means and in any form or format, making this thesis available to interested persons.

L'auteur a accordé une licence irrévocable et non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de sa thèse de quelque manière et sous quelque forme que ce soit pour mettre des exemplaires de cette thèse à la disposition des personnes intéressées.

The author retains ownership of the copyright in his/her thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without his/her permission.

L'auteur conserve la propriété du droit d'auteur qui protège sa thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

ISBN 0-315-65050-8

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR Wayne G. Tymchuk

TITLE OF THESIS Testing for Bias in the Canola Futures Market

DEGREE FOR WHICH THESIS WAS PRESENTED Master of Science

YEAR THIS DEGREE GRANTED Fall, 1990

Permission is hereby granted to THE UNIVERSITY OF ALBERTA LIBRARY to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly or scientific research purposes only.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

(SIGNED) Wayne Tymchuk

PERMANENT ADDRESS:

11605 - 71 street
Edmonton Alberta
T5B 1W3

DATED Oct. 9 1990

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Testing for Bias in the Canola Futures Market submitted by Wayne G. Tymchuk in partial fulfillment of the requirements for the degree of Master of Science in Agricultural Economics.

.....Michele Veeman.....

Dr. Michele Veeman, Supervisor

.....

Dr. Vic Adamowicz,

.....Paul Boothe.....

Dr. Paul Boothe.

Date ..Oct. 9/1990

To My Mother and Father:

Abstract

The central theme of this study will be to confront the theory of unbiasedness of a futures market with real world data. The expectation is that a futures market will predict subsequent cash prices without bias. In this study, data from the canola market on the Winnipeg Commodity Exchange is used to assess this hypothesis.

In this study the hypothesis that the canola futures market is unbiased is confronted with real world data. This statistical study took a two-pronged approach to testing the hypothesis. The first method examined whether or not the futures market price follows a random walk. If the market did not follow a random walk, then bias, evidenced by a general drift, on average, must be present. The second method of assessment used an instrumental variable regression approach to the traditional analysis using futures prices as an independent variable and expiration prices as the dependent variable to check if the futures market is unbiased.

To check the random walk theory, three tests were applied to a matrix of the daily price changes of fifty four futures contracts. From the results of each test, the hypothesis of random walk and unbiasedness had to be accepted. In the second method, using an instrumental variable technique to overcome a problem of using Ordinary Least Squares, the hypothesis of unbiasedness was accepted

at all lags tested. The results indicate that we cannot reject the hypothesis that the canola futures market is unbiased.

Acknowledgements

No words here can express my gratitude to my parents for all that they have done for me, but hopefully this, in some small way, communicates that thanks:

Thank you Mom and Dad !

Thanks go to my committee members Dr. Michele Veeman, Dr. Vic Adamowicz and Dr. Paul Boothe for all of their guidance.

I owe thanks to all of my immediate family, including Greg and Carol, and my extended family who all gave me immeasurable support and encouragement in achieving this goal.

Additional thanks has to go to all of my friends including Dan, Ed, Gail, Lance, Gary, Lydia, Otto, Keith, Maria, Peter, LeAnne, Doug, Georgina, the Mcloughlins, and oh yes, Ted and Susie.

Thanks are also due to my fellow staff members at N.A.I.T. for their contributions.

A special thanks goes out to all the support staff in Rural Economy including the office staff, the librarians, and the staff of the computer room.

The faculty and students in Rural Economy deserve thanks for it was through them it was possible for me to achieve this objective.

Please forgive me if in reading this you find yourself unmentioned; it is not that I have forgotten you or that you are unimportant because you are important. Thank you!

Table of Contents

Chapter 1 Introduction 1
1.1 Objective 1
1.2 Background 1
1.3 Importance 6
1.4 Summary 8

Chapter 2 Literature Review 10

Chapter 3 Outline of Theory 17
3.1 Nature of Problem 17
3.2 Futures Market Relations 22
3.3 Tests 24

Chapter 4 Methodology 27
4.1 Introduction 27
4.2 Log Ratio Approach 27
4.3 Instrumental Variable Approach 35
4.4 Data 40

Chapter 5 Results 42
5.1 Introduction 42
5.2 Log Ratio Approach 42
5.3 Instrumental Variable Approach 45

Chapter 6 Conclusions 50
6.1 Introduction 50
6.2 Summary to the Study 50
6.3 Implications 51
6.4 Limitations 52
6.5 Alternative Methods 53
6.6 Concluding Statement. 54

Bibliography 55

Appendix A 61

Appendix B 66

Appendix C 71

Table of Tables

Observed Number of Significant 't' Values 43

Results of Instrumental Variable Regression 46

Hypothesis of Instrumental Variable Technique 49

Hypothetical Four Treatments to Prove Modified ANOVA 63

Means of Daily Price Changes and 't' Statistics 66

Chapter 1

Introduction

1.1 Objective

The central theme of this study will be to confront the theory of unbiasedness of a futures market with real world data. The expectation is that a futures market will predict subsequent cash prices without bias. In this study, data from the canola market on the Winnipeg Commodity Exchange is used to assess this hypothesis.

1.2 Background

Canola (rapeseed) oil accounts for 12 percent of world production of major vegetable oils and its production continues to increase. Canada and France are major exporters of this oilseed. Canada is estimated to have produced 3,400,000 metric tonnes (Commodity Research Bureau (C.R.B.) Yearbook 1986) of canola in 1985 alone.

In Canada, canola is a cool weather crop planted in May and harvested in August. It is particularly vulnerable to unpredictable weather patterns, being susceptible to frosts in spring and fall and very intolerant to dry conditions. Canola should be grown on fertile soil or in soil enriched with a large amount of fertilizer. Overall, canola is a very management-intensive crop relative to alternative crops.

Canola has been called the "Cinderella Crop" for prairie farmers. As it is an unregulated agricultural commodity, it responds to free market prices on the Winnipeg Commodity Exchange rather than to pooled prices through the Canadian Wheat Board (C.W.B.). However, transportation is regulated. Due to the relationship between barley and the C.W.B., the two crops are ultimately in competition for the same acreage. The importance of canola to prairie province farmers is reflected in its contribution to gross farm revenue. Canadian farmers have a substantial acreage in canola, so much so that the combined area of Southern Manitoba, Saskatchewan and North Central Alberta accounts for eight to ten percent of the world rapeseed production.

Canola is traded on the Winnipeg Commodity Exchange. In the 1973/74 crop year 322,848 contracts of rapeseed were traded and that volume has expanded to 929,599 contracts in the 1984/85 crop year. Each of these contracts represent 20 metric tonnes of canola with delivery dates of January, March, June, September and November. The canola contract normal deliverable grade is number one and is deliverable to Vancouver.

The futures market serves four particular functions. The first is that of risk management. Futures markets have been used as a risk management tool from their outset. An application of the futures market as a risk

management tool can be seen when a grain producer hedges his/her crop for future sale. The risk of price change has now been transferred to the purchaser of the futures contract, most likely a speculator. Hedging can be undertaken for a large number of reasons which include the protection of prices of inventories or the protection of uncovered forward sales of products. Risk management thus protects against market risk, not production risk.

The second function of the futures market is its provision of price signals for storage of a commodity. The price difference between contracts that expire on different dates represents the cost of storage. This price difference induces storage, which is one of the primary reasons futures markets were developed. This inducement to storage, if not normally priced, will allow for arbitrage which will quickly adjust the prices to a normal relationship.

The third function of a futures market is that of information gathering and distribution (a process reflected in the prices). The market that correctly and effectively employs this information is termed an efficient market. Fama (1970) described three tests of market efficiency. Weak form market efficiency is found when prices adjust to information represented in past prices. Semi-strong market efficiency is established when prices adjust to other available information, such

as prices of substitutes or shifts in demand. This information must be available to the public. A strong form test of market efficiency is distinguishable from the semi-strong test in that information necessary for adjustment is not publicly available. A strong form test of market efficiency is an attempt to see if some individuals have special or monopolistic access to information that would result in supra-normal profits. An example of these types of individuals is given by floor traders on a commodity exchange.

The fourth function of the futures market is its ability to act as a predictor of cash prices in the future. It is this function that will be the focus of this study. The futures market price is an estimate of the spot (or cash) price on the expiry date of the contract. Traders look at both sides of the market, expected supply and expected demand and their interactions, to arrive at an expected equilibrium price or market clearing price. On the supply side such elements as weather (for an agricultural commodity) or labour strikes (for perhaps a metal) are researched.

The issue of bias arises if the expected market clearing price is systematically different from the futures market price. This could happen if the futures market has an excess amount of short hedging pressure. This could occur if a large number of farmers want to

sell their commodity but there are not enough speculators and/or long hedgers to buy all the contracts that are being sold. The long hedgers could include mills buying in the futures market to protect inventory costs or exporters buying in the futures market to guarantee delivery obligations. The excess volume of short hedging would have to provide encouragement to the long hedgers and speculators to cover the contracts. Short hedgers would do so by lowering the price of the futures contract (due to excess supply) thereby motivating, with profits, the speculators and long hedgers to enter the market place. These profits would arise from the difference between the futures price and expected future spot price. Since the expected spot price would not be equal to the futures price, the futures price would be biased. The futures market price would reflect a premium to attract speculators to the market. John Maynard Keynes called this downward price bias of the futures market 'normal backwardation'.

The opposite case may happen as well. The pressure from long hedgers may be greater than from those wishing to sell futures. These long hedgers would be in need of the commodity and wish to purchase futures contracts to lock in prices for future use of the commodity. In this situation long hedgers must attract short hedgers and speculators to enter the market to offset their

contracts. There is excessive demand for the contracts, so the price will rise. The name given to this upward price bias is 'contango'. Again, the futures market price is not equal to the expected spot price but in this case it is biased upward.

Intuitively there should be no contango or normal backwardation. There should be no oversupply of long or short hedgers; the quantity of commodity that is supplied should be equal to that which is demanded. That is, for every bushel of grain supplied by a farmer, there should be a bushel demanded by a miller or exporter. In fact the only things that might contribute to an excess of long or short hedgers is the lack of sophistication of hedgers using the futures market or differences in risk preferences of different groups.

The objective of this empirical study is to investigate whether the canola futures market serves as an unbiased predictor of spot prices. As Giles and Goss (1981) point out, this hypothesis rests on three assumptions about the futures market: the market is competitive, it makes rational use of information, and the economic agents operating in the market are risk neutral.

1.3 Importance

The unbiasedness of a futures market is of importance to a variety of groups of people. Government and industry

regulators would be concerned about the working of futures markets. Their interest would be that a market is, in effect, a fair game where no one is advantaged and no one is disadvantaged. The necessity for some to pay a premium to participate in the futures market could be viewed as a disadvantage. Industry regulators might be especially responsive to this; if a futures market is seen as unfair, this suggests problems in that particular futures market. If the particular market is for a relatively new contract, this might be corrected over time. However, bias could show that a contract is thinly traded, poorly specified, or losing its usefulness. It might be that a market displays poor behavior and that the futures market is not a fair game; this could dissuade increasing numbers of traders, contributing to poor market performance.

The traders who use the futures market, both speculators and hedgers, are most concerned with profits, and a futures market that is identified as biased would mean excess profits for some and decreased profits for others. Those who experienced decreased profits would probably avoid using that particular futures market which could result in thin trading, possibly more bias and eventually perhaps the demise of the futures market. This would decrease the market choices for speculators and decrease the marketing alternatives for hedgers.

A variety of economists would also be interested in this issue. Agricultural economists could point to the futures markets as a fair game which speculators and hedgers could use with confidence as a vehicle of speculation or as a marketing tool. Financial economists would be interested as the methods employed here could be used in other futures markets. Finally, macro-economists would be interested as well, specifically the relatively new school of macro-economists concerned with rational expectations. These economists point to the workings of the futures market, where predictors of tomorrow's prices occur today and these price forecasts are based on expectations, as partial proof of their theories.

1.4 Summary

This study has five remaining chapters. Chapter Two gives a brief look at some of the studies of the extensive number of studies which examine bias in a futures market (and closely related topics). As no clear consensus on this issue of bias has been reached, examples of both points of view have been presented. Chapter Three provides a discussion of the theory of bias in a futures market. Included is a brief discussion of the related subjects of efficiency, bias and forecasting performance of the futures market. Chapter Four presents the two methods used in this study to test the theory of unbiasedness with real world data in an attempt to test

the central hypothesis that the canola futures market is an unbiased predictor of spot prices. Chapter Five presents the results of these two methods. The last chapter, Chapter Six, outlines the conclusions of this study and discusses implications of it, as well as shortcomings of this study. Further extensions, alternative methods and improvements will also be noted in this chapter.

Chapter 2

Literature Review

Other writers have approached the question of unbiasedness and the results have been varied. In his 1974 study, Leuthold addressed the question of the price performance of futures market for the non-storable commodity of live cattle. He found that the futures market for live beef estimated cash prices as accurately as for the continuous inventory commodity of corn. Using beef, a mean square error (M.S.E.) model was calculated as the difference between the futures price and its expiration price; this was compared to an M.S.E. model that calculated the difference between beef spot prices and the beef futures expiration price. Leuthold found that the futures price served as the best predictor of the expiration price, from expiration up to the 15th week prior to delivery. Preceding the 15th week to expiration, the cash beef price serves as a better predictor of subsequent expiration price. Restated, cash prices are more stable than futures prices. The results of this study suggest that in making their production decisions, producers would benefit more from a careful examination of cash prices. He presents some discussion of this point, as well as possible reasons for the more successful result of cash prices as a predictor. Leuthold suggests that the poorer performance of the futures market could be due to the market being thin or that this result is

peculiar to a market for non-storable commodities. It would appear that this researcher fails to address the possibility that producers are greatly influenced by cash prices in their production decisions and their marketing decisions. In other words, this may not be a structural problem of the futures market but one of unfamiliarity with, or caution of producers, in using, futures markets.

Giles and Goss (1981) studied futures and cash prices as forecasts in the live cattle and wool markets of Australia. These two commodities were isolated in order to contrast a continuous inventory commodity (wool) and a non-storable commodity (live cattle). The authors expected to find a linear relationship between the cash and futures prices and, to this end, used a modified instrumental variable technique. They found, with few exceptions, that lagged futures prices are an unbiased predictor of wool prices (for lags of one to twelve months) as well as for live beef prices (for lags one to three months). The study also examined if lagged cash prices were an unbiased predictor and found that, although the hypothesis was rejected for beef, it could be accepted for wool. The authors attribute this to the fact that continuous inventory commodity markets perform their forecasting function more efficiently than the non-storable commodity market. They

also point out that the relative age of a futures market for a commodity may have an important influence on its efficiency.

Kahl and Tomek, in their 1986 paper, examine the question of the predictive and unbiased qualities of selected futures markets. The authors disaggregated their data; that is, they utilize each contract month and several lags. In the case of corn, with 5 contract months and 4 lags, the result was that they estimated 20 equations. The analysis of soybeans, with 7 contracts and a selection of 4 lags, resulted in 28 equations. The study included cattle as a third variable. The authors first estimated these equations using Ordinary Least Squares (O.L.S.). The intercept was positive and the slope negative for all commodities in almost all equations. As the lag length increased, both the slope and intercept tended to increase. As well, the coefficients for approximately half of the equations were significantly different from zero. The O.L.S. 't' statistics improved as the sample size increased when contract months were pooled. Also, the results were greatly improved when an outlier associated with the 1973 soybean embargo was removed. Seemingly Unrelated Regressions Equations (S.U.R.E.) procedures were also used to estimate the lags for each contract month. In general, the results showed that the S.U.R.E. estimates had higher 't' statistics and that the estimated coefficients were

farther away from zero. As in O.L.S., the intercept was positive and the slope negative in all regressions using S.U.R.E. The authors' conclusions are that these markets failed tests of weak form market efficiency.

Two criticisms can be directed at the study by Kahl and Tomek. The first is that the use of such small samples for each of the equations may lead to biased estimates of the estimators. A second criticism is that the choice of using a S.U.R.E. estimate may be inappropriate for this estimation. The use of a S.U.R.E. technique is appropriate when the independent variables are uncorrelated while the error terms are correlated. In their analysis Kahl and Tomek assume that the futures prices for all contracts, and for all lags, are uncorrelated. It would appear that the futures prices of different contracts for the same (and even different) lags cannot be treated as independent. In theory, the price difference between contracts simply exhibits the cost of storage. The prices of the futures market reflect supply and demand curves that are directly correlated to different months.

To further the debate on whether there is bias in a futures market, Veeman, Burden and Dong examined the canola and soybean futures markets. They used the classical method of regressing futures prices prior to expiration on the expiration price of that contract. The time differences examined were from one to eight months.

The first run involved pooling all contracts together. The second run involved disaggregating the data and only using contracts with the same expiry month. The authors used the most heavily traded months as well as the most thinly traded contracts.

The results for the canola pooled contracts showed that the farther away from expiration the less accurate the futures prices were in predicting subsequent spot prices, which is what would be expected. As more information becomes available about the expected supply and demand situation in the future the better the market can forecast spot prices. The pooled soybean contracts showed even less forecasting ability than canola but the estimated coefficients had less variability.

The disaggregated model involved only using the November and March contracts for canola. The former is the most heavily traded and the latter the most thinly traded. The results showed that the heavily traded contract gave better forecasting ability as compared to the thinly traded contract. This would be as theory would predict. The soybean prices were disaggregated in a similar manner with the November contract representing the most heavily traded contract and the September contract as the lightly traded one. The results here showed there was little difference between the heavily traded contract and the lightly traded

contract. The much higher level of trading in the soybean market year-round as compared to the canola market could easily explain this inconsistency.

This study can also be criticized. One point which the authors themselves briefly discuss and attempt to address in an appendix is the fact that using a lagged dependent variable as an independent variable can give biased results. The study used Seemingly Unrelated Regression Equations (S.U.R.E.) method to overcome this, but as the authors point out, S.U.R.E. is ill suited due to the high correlations between the futures prices.

Another criticism which can be leveled against the authors and should be questioned is their insistence that the futures contracts should be disaggregated. Not only does disaggregating the data result in a very small sample size which can create statistical problems but also, as the study recognizes, using only one contract month (i.e. November) a great number of years must be used. Market structure changes over the large number of years may have an effect on the results of the study. A third reason that the contracts can be pooled is that the differences between contracts should amount to the difference in basis. If not, arbitragers will have an incentive to buy one contract and sell another.

This chapter presented a short examination of some of the literature concerning futures market efficiency. It is evident from the literature that there is no clear cut

answer to the question of market bias or efficiency. Authors of survey articles such as Leroy (1989) arrive at the same conclusion. Although there is no consensus, the evidence seems to weigh heavily on the side of the theory that there is market efficiency or unbiasedness. The aim of this statistical study is to help in some small manner to clarify this matter.

Chapter 3

Outline of Theory

3.1 Nature of Problem

This chapter will focus on the explanation of the theory that will be applied in testing for bias in the futures market. It will start from a very restricted model and gradually relax some of the restriction to provide for more realism in the model. The chapter will conclude by specifying the equations that will be estimated in this study.

The starting point with the very restricted model invokes a very unrealistic view of the futures market. The first assumption, which will be relaxed later, is that there are no economic costs of holding or moving a commodity through time (money is included here as a commodity). The second assumption is that the supply of the commodity is fixed.

Using these restrictions would cause the spot price of a commodity and its futures price to equal each other. Algebraically this is expressed as

$$FP_{(t+1)} = SP_t \qquad (1)$$

where $FP_{(t+1)}$ equals the futures price at time $t+1$ and SP_t equals the spot price today of that commodity.

If a price difference existed, arbitragers would gain by exploiting this price difference. For example, if the

futures price was greater than the cash price, arbitragers would buy in the cash market and sell in the futures market; that is, they would profit by exploiting the price difference between these two markets, since

$$FP_{(t-1)} - SP_t = \pi \qquad (2)$$

where π = unit profit.

If the price relationship between the two markets was the opposite, that is, if the spot price was higher than the futures price, then arbitragers would buy in the futures market and sell in the spot market. Restated algebraically,

$$SP_t - FP_{(t-1)} = \pi \qquad (3)$$

As more arbitragers entered the market, the price difference between the spot and futures price would get smaller until finally there would be no remaining profit. That is,

$$SP_t - FP_{(t-1)} = 0 \qquad (4)$$

Moving the negative term to the right hand side gives

$$SP_t = FP_{(t-1)} \qquad (5)$$

This equation is identical to equation (1).

The most obvious restriction, which will be relaxed first, is that there are no economic costs of moving the commodity through time. Storage costs or carrying costs will be added to the model. Working, in 1948, hypothesized that a futures market price would equal the

spot price plus the normal cost of storage including insurance, i.e. carrying costs, until the expiration of that contract. Algebraically,

$$FP_{(t+1)} = SP_{(t)} + carrying\ \ costs \qquad (6)$$

Again, if this relationship does not hold, arbitragers would have a profit incentive to buy and sell until the difference between $FP_{(t+1)}$ and $SP_{(t+1)} + carrying\ \ costs$ equals 0.

Another component of cost not included in the above case is the opportunity cost of money tied up in a stored commodity. If, for example, an arbitrager bought a quantity of the commodity, the money used could have made money for the arbitrager in an interest-bearing security. This opportunity cost must be incorporated into the model. The futures price must equal the spot price including the cost of money plus the carrying costs or,

$$FP_{(t+1)} = SP_t(1 + I_{t\rightarrow(t+1)}) + carrying\ \ costs \qquad (7)$$

where I is the interest rate and the quantity involved is the fixed or the standard amount of a futures contact.

The restriction of a fixed supply of the commodity is the next to be relaxed. In the real world, knowledge of the actual supply of a commodity in a futures market is sometimes impossible to specify. Futures contracts for agricultural commodities frequently begin trading before the crops have even been planted, so estimating supply is

very difficult. It is assumed that expectations of the future spot price are developed using all of the available information. Arbitragers would then use the futures price as the best estimate of the future spot price. Thus arbitragers would buy or sell in the future using a price that best approximates the future spot price, that is, the futures contract price. Algebraically this can be expressed as

$$E_t(\hat{SP}_{(t+1)}) = FP_{(t+1)} \tag{8}$$

That is, the estimate, at time, t (E_t) of the spot price, at a time in the future, ($\hat{SP}_{(t+1)}$) equals the futures price at time t ($FP_{(t+1)}$). The futures price forms an unbiased prediction of the spot price sometime in the future.

We have two equations with the futures price on the left hand side, equation (7) with current supply available and equation (8) without current supply available. Putting the two together, the futures price then becomes

$$FP_{(t+1)} = \min[E_t(\hat{SP}_{(t+1)}), SP_t(1 + I_{t\to(t+1)}) + carrying_costs] \tag{9}$$

However, if we allow arbitrage activity, the estimate of the spot price in the future and the spot price in the current period (accounting for the opportunity cost of money and the carrying cost of the commodity) will be equal. Restated, the difference between $\hat{SP}_{(t+1)}$ and $SP(1+I)$ will equal zero. For example, if the estimate of

the spot price in the future is very high due to an expected shortage of supply, then arbitragers will buy the commodity in the spot market and sell it on the futures market, expecting a higher price later. The excess demand for the actual commodity in today's spot market will drive up the spot price today until the difference between the two prices equals zero. No matter which price is out of equilibrium, the futures price, the spot price today, or the estimated spot price in the future, and for whatever reason, it is expected that arbitragers driven by the search for profits will ensure that a new equilibrium will emerge that satisfies equation (9).

There are some glaring omissions from the model outlined above. The first is that we assume that there is no risk premium. A risk premium could be incorporated in the model as R giving

$$FP_{(t+1)} = 1 - R[\min[E_t(\hat{SP}_{(t+1)}), SP_t(1 + I_{t\to(t+1)}) + carrying\,costs]] \quad (10)$$

However, if we assume no risk premium, that is, $R = 0$, the equation becomes

$$FP_{(t+1)} = 1 - 0[\min[E_t(\hat{SP}_{(t+1)}), SP_t(1 + I_{t\to(t+1)} + carrying\,costs]] \quad (11)$$

or simply equation (9) above.

Another limitation of the above system is that it is relatively stable. In practice, however, new information about the commodity can become known. It is assumed that

the market uses this information immediately, setting a new price that reflects the new equilibrium or the expected equilibrium. The assumption will be made that the markets do not err in using this information and that this new information arrives randomly and is not predictable.

3.2 Futures Market Relations

The theory relating to efficiency of futures markets incorporates five relations. These relations can be applied to assess whether a market is efficient. As discussed here, efficiency can be replaced with the term 'best forecasting performance' or 'expectations are rational'. This section draws heavily from Stein (1986).

The first relation involves the futures price and the subsequent spot price and is that the difference between these two prices is random in nature. Thus

$$FP_{(t+1)}(t) - SP_{(t+1)} = u \qquad (12)$$

Today's futures price of the price tomorrow less the spot price tomorrow yields a random element or error term (u) that is stochastic, has no structure and has a mean of zero.

The second relates to the changes in futures prices that are due to changes in information:

$$FP_{(t+1)}(t) - FP_{(t+1)}(t-1) = \Phi(t) \quad and \quad E\Phi = 0 \qquad (13)$$

Today's futures price of tomorrow's price changed from yesterday due to new information that arrived today. It is assumed that this information is random, not predictable and the market does not err in using this information. The expectation of this information equals zero.

The third relation is that futures markets are fair games or martingales. Algebraically it takes the form

$$E(FP_{(t+1)};\Phi_t) = FP_{(t+1)}(t) \qquad (14)$$

Restated, the price expectation conditional on information today equals its present value.

The fourth is that no trading technique is expected to make consistent economic profits. In equation (15), W denotes wealth and Z the trading rule. If Z equals -1 then the trader will sell; if Z is +1 then the trader buys.

$$W(t) = W(t-1) + [FP_{(t+1)}(t) - FP_{(t+1)}(t-1)]Z(t-1) \qquad (15)$$

Restated, no constantly used trading system will be continually profitable. Certainly the real world bears this assumption out, since some estimates put the number of unprofitable investors at 75% of total investors.

The final relation has to do with the relation between spot price and futures prices. It states that the spot

price tomorrow is the futures price of that price today adding in all the knowledge that comes available.

$$SP_{(t+1)} = FP_{(t+1)}(t) + \sum \Phi \qquad (16)$$

As Stein (1986) points out, all of the literature involved with the efficient market theory is based in whole or in part on these five relations or predictions.

3.3 Tests

The five relations or predictions outlined above lead to the three main tests of the efficient market theory. The first test is one that examines if the market follows a random walk. It takes the form that the difference between the spot price tomorrow and the futures market price of that price equals an error term that has no structure, is random or is just noise. Algebraically this can be stated as

$$SP_{(t+1)} - FP_{(t+1)}(t) = e(t+1) \qquad (17)$$

The path that the futures price follows is random. If this was not true and if there was bias in the market, a general drift in the futures market would be noticed as the prices approached expiration.

The second test of the efficient market theory is considered to be the classic test of bias in a market:

$$SP_{(t+1)} = \beta_0 + \beta_1 FP_{(t+1)}(t) + e \qquad (18)$$

where β_0 and β_1 in the above equation should equal 0 and 1 respectively. The test has also taken the following form:

$$SP_{(t+1)} - SP_t = \beta_0 + \beta_1 (FP_{(t+1)} - SP_t) + e \qquad (19)$$

The only change from equation (18) is that today's spot price has been subtracted from both sides of the equation. (Frequently these two equations are transformed by taking the natural log of all data.)

The third test is to determine if the futures price is the best predictor of a cash price in the future or whether some other available information can be incorporated to make a better prediction. In the equation below, the third term represents the summation of any other extra information at time t used to improve the prediction.

$$SP_{(t+1)} = \beta_0 + \beta_1 FP_{(t+1)}(t) + \sum_{i=1}^{m} c_i \phi_i(t) + e \qquad (20)$$

The expectation is that β_0 and c equal zero and β equals one.

This test for market efficiency has been applied in many studies. One example is the testing of the foreign exchange market by Longworth, Boothe and Clinton who tested the efficiency of this market (Longworth et. al., 1983). These authors included a GNP or GDP deflator as a proxy for purchasing power parity as a third explanatory variable in the above equation.

This study will test the theory of unbiasedness in the canola market using the first two of the tests outlined above.

Chapter 4

Methodology

4.1 Introduction

This chapter will focus on explaining the methodology used to test empirically the theory of unbiasedness in the futures market. Two methods were used, the first essentially testing to see if the futures market follows a random walk (equation (17) above). That is, it checks to see if there is any drift on average in the canola futures market. The second method addresses the problem of unbiasedness in another way; it examines equation (18) above. This section uses an instrumental variable technique. It overcomes the problem of using a lagged dependent variable as an independent variable that usually arises when the classical method of testing for unbiasedness by regressing futures prices on spot prices is applied.

4.2 Log Ratio Approach

The method described here draws heavily from Kolb and Gay (1983). If the expected spot price tomorrow equals today's futures price for tomorrow, the following expression applies:

$$FP_t = E(SP_{(t-1)}) \qquad (21)$$

Also if expectations are unbiased, then tomorrows expected spot price in today's time period would equal

the spot price tomorrow.

If the futures price (FP) at $t+1$ equals the spot price SP on that day, or

$$FP_{(t+1)} = SP_{(t+1)}. \tag{22}$$

Equating equation (21) and equation (22) provides

$$FP_t = FP_{(t+1)} = SP_{(t+1)} \tag{23}$$

If this is true, then

$$\frac{FP_{(t+1)}}{FP} = 1 \tag{24}$$

But there are more than two days in the life of a contract; in fact, there are $t, t+1, t+2, t+3, \ldots$ etc. Thus, expanding equation (24) results in

$$\frac{FP_{(t+1)}}{FP} = \frac{FP_{(t+2)}}{FP_{(t+1)}} = \frac{FP_{(t+3)}}{FP_{(t+2)}} = \ldots = 1 \tag{25}$$

Taking the natural logs of equation (25) yields

$$\mathrm{Ln}\left(\frac{FP_{(t+1)}}{FP_t}\right) = \mathrm{Ln}\left(\frac{FP_{(t+2)}}{FP_{(t+1)}}\right) = \mathrm{Ln}\left(\frac{FP_{(t+3)}}{FP_{(t+2)}}\right) = \ldots = 0 \tag{26}$$

Overall, the net differences of the price changes should equal zero. This could be calculated for a number of futures contracts. The expectation is that the result will equal zero; however, examining only one contract would seem somewhat unreasonable since, in the life of a contract, prices do change. For example, with a contract whose price starts low and expires higher, the result from equation (26) would not equal zero. Similarly, if

the contract price starts high and then trends lower until expiration, the result of equation (26) again would not equal zero.

If, however, a large sample of contracts was examined, then the expected result of equation (26) should hold. This could be assessed by stacking contract results on top of each other, or

$$\begin{array}{ccccccccc}
\text{Ln}\left(\frac{FP^1_{(t+1)}}{FP^1_t}\right) & = & \text{Ln}\left(\frac{FP^1_{(t+2)}}{FP^1_{(t+1)}}\right) & = & \text{Ln}\left(\frac{FP^1_{(t+3)}}{FP^1_{(t+2)}}\right) & = \ldots & \text{Ln}\left(\frac{FP^1_{(t+m)}}{FP^1_{(t+m-1)}}\right) & = & 0 \\
\text{Ln}\left(\frac{FP^2_{(t+1)}}{FP^2_t}\right) & = & \text{Ln}\left(\frac{FP^2_{(t+2)}}{FP^2_{(t+1)}}\right) & = & \text{Ln}\left(\frac{FP^2_{(t+3)}}{FP^2_{(t+2)}}\right) & = \ldots & \text{Ln}\left(\frac{FP^2_{(t+m)}}{FP^2_{(t+m-1)}}\right) & = & 0 \\
\vdots & & \vdots & & \vdots & & \vdots & & \vdots \\
\text{Ln}\left(\frac{FP^n_{(t+1)}}{FP^n_t}\right) & = & \text{Ln}\left(\frac{FP^n_{(t+2)}}{FP^n_{(t+1)}}\right) & = & \text{Ln}\left(\frac{FP^n_{(t+3)}}{FP^n_{(t+2)}}\right) & = \ldots & \text{LN}\left(\frac{FP^n_{(t+m)}}{FP^n_{(t+m-1)}}\right) & = & 0
\end{array} \tag{27}$$

where the superscript on FP designated n represents a different contract and the subscript on FP designated m represents days from initiation of the contract.

If the columns of the above matrix were examined it would be expected that the averages would equal zero as any deviations for individual contacts would cancel out. Restated, the test takes the form

$$\overline{\text{Ln}\left(\frac{FP_{(t+1)}}{FP_t}\right)} = \overline{\text{Ln}\left(\frac{FP_{(t+2)}}{FP_{(t+1)}}\right)} = \overline{\text{Ln}\left(\frac{FP_{(t+3)}}{FP_{(t+2)}}\right)} = \ldots \overline{\text{Ln}\left(\frac{FP_{(t+m)}}{FP_{(t+m-1)}}\right)} = 0 \tag{28}$$

or, for notational compactness

$$\overline{LR_1} = \overline{LR_2} = \overline{LR_3} = \ldots = 0 \tag{29}$$

where the LR notation represents log ratios and the bars represent averages.

In this study three procedures are used to examine the expected result of all the column averages equalling zero. The first procedure is that a simple 't' test will be applied to see if the means are actually equal to zero. The expectation here is that the column averages will not be different from zero.

A statistical shortcoming arises from this test. As more independent samples are examined, it is more likely that a type I error will be made. (A type I error is one where the null hypothesis is rejected when it is actually true.) If one sample is tested, then the probability of not making a type I error is $1-\alpha$ where α equals the level of significance. Using the rule of multiplication of independent events and having a large number of samples we get

$$(1-\alpha)(1-\alpha)(1-\alpha)...(1-\alpha) \qquad (30)$$

or

$$(1-\alpha)^c \qquad (31)$$

where c equals the number of samples.

Therefore, the probability of getting one or more type I errors is

$$=1-(1-\alpha)^c \qquad (32)$$

In the case of this study, where 200 days before each contract expiration is examined, the result is

$$1-(1-.05)^{200} \qquad (33)$$

or .999964947 where the significance level equals five percent. This is the probability of making a type I error in this portion of this study. As this probability is approaching certainty, one could question the validity of this test. However, when this test is used on an individual sample it is still very powerful. As this study examines 200 samples, expectations would be that with a level of significance of five percent ($\alpha = .05$), about ten of the samples would show means different from zero due to sampling or random error alone.

The test in detail, then, is that the means of the columns of the above matrix will be tested to determine if they are different from zero, or

$$H_0: \mu = 0;$$

$$H_1: \mu \neq 0.$$

The calculated test statistic is

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} \qquad (34)$$

with n-1 degrees of freedom.

The level of significance will be five percent. Thus, the critical value which will be used is 2.01. Therefore

if the calculated value is equal to or greater than 2.01 or less than or equal to -2.01 the null hypothesis will be rejected.

The second test procedure of equation (29) uses an 'F' statistic test that jointly tests all the column averages to see if they are different from zero. This method is presented by Sarkadi and Vincze (1974)(See Appendix A). This technique is a modified analysis of variance (ANOVA) test. The typical ANOVA in the numerator examines the total sum of squares which takes the difference between a column mean ($\bar{x}$) and compares it to a grand mean ($\bar{\bar{x}}$) or

$$(\bar{x} - \bar{\bar{x}}) \tag{35}$$

The statistical method used here replaces the grand mean with a constant.

In detail, the test is

$$H_0: \ \overline{LR}_{(t*m)} = 0 \qquad m = (1, 2, 3 \ldots)$$

$$H_1: \ at \quad least \quad one \quad \overline{LR} \neq 0$$

where $\overline{LR}_{(t*m)}$ are the column averages for the matrix (27) above. The significance level is five percent ($\alpha = .05$). The test statistic is

$$F = \frac{MS_{bg}}{MS_{wg}} \tag{36}$$

where the calculated F statistic is equal to the mean square between groups (or columns) divided by mean square within the groups themselves.

Where

$$MS_{bg} = \frac{m \sum_{i=1}^{k} (\bar{x} - C)^2}{k - 1} \tag{37}$$

and

m is the number in each column in the sample;

$\bar{x}$ is that column average;

C is the constant to be compared against (0 in this study);

k is the number of columns

and

$$MS_{wg} = \frac{\sum_{i=1}^{k} \sum_{i=1}^{m} (x - \bar{x})}{mk - k} \tag{38}$$

The degrees of freedom in the numerator of the 'F' statistic is k-1; in the denominator this is mk-k. The critical value for this 'F' test is 1.70. If the 'F' calculated is equal to or greater than 1.70, then the null hypothesis is rejected.

The third and final test of equation (29) (the log ratio means) is to run a regression of the number of days to expiration against the column averages. The expectation is that there is no correlation between the

number of days to expiration and the log ratio averages. If the expectations of this were plotted on a graph with the days to expiration on the horizontal axis and the log ratio value on the vertical axis, the result should be that the line coincides with the positive y axis. If, however, there was bias in the futures market, the relationship would look quite different. If bias was present, the regression line possibly might originate at the intersection of the x and y axes; it would be a line with either a positive or negative slope that lies to the right of the y axis.

Restated, the regression would take the form

$$\overline{LR}_{(t+m)} = \beta_0 + \beta_1 M + u \qquad (39)$$

where M is the number of days from initiation of the log ratio means.

The expectation is that the estimated coefficients will equal zero. If there is bias (either contango or normal backwardation), these coefficients will not equal zero. It is also expected that this regression should show low overall significance; restated, the 'F' statistic for the overall equation should be below its critical value . That value is 3.88 (if a significance level of five percent is used). As well, the R squared would be expected to be very small. This would show that the price of the contracts as they continue to expiration

show no structure or drift.

4.3 Instrumental Variable Approach

In the classic test of bias in a futures market, a regression equation is estimated using the futures price as an independent variable, and the spot or closing price as the dependent variable. The regression equation takes the form

$$SP_{(t-1)} = \beta_0 + \beta_1 FP_t + u \qquad (40)$$

A problem arises using O.L.S. estimation because an O.L.S. assumption is that the independent variable is uncorrelated with the error term which is not the case here. The lagged dependent variable is actually used as an explanatory variable. An alternate method to estimate this equation and overcome this problem is to use the instrumental variable technique.

The instrumental variable technique uses exogenous variables that act as instruments or proxies for the independent variable or variables. The instrumental variable method works for exactly identified or overidentified equations. Overidentified in this context means that the number of excluded exogenous variables is greater than the number of included endogenous variables less one.

The difficulty with the application of this method is the choosing of variables to act as instruments. The

criteria in selecting instrumental variables for estimating equation (40) are as follows. Most importantly, the instrumental variable chosen must be correlated with the endogenous variable (FP_t) because it will essentially act as its proxy in the execution of the instrumental variable technique. The second criteria is that the instruments should not be correlated with the error term.

As equation (40) has two endogenous variables, at least one exogenous variable is required. Two exogenous variables were used because the more information the exogenous variables bring, the less the variance of the estimation will be. The two instrumental variables chosen here are the Commodity Research Bureau index which is a compilation of 21 commodities and the soybean oil price. The Commodity Research Bureau (C.R.B.) index was chosen as one instrumental variable because of the high correlation of variation (83%) found between oilseeds prices and the index (C.R.B. Yearbook 1982 p. 270). Because canola is processed into an oil which competes on the market with soybean oil, the price of soybean oil was selected as the other instrumental variable. Soybean meal was not included as a variable because canola meal is a relatively minor by-product. The price of soybean itself was not incorporated because its price reflects

both the supply and demand of oil and the supply and demand of meal, which does not compete in demand with canola.

The major drawback of using this technique is that the estimates have a higher variance than O.L.S. estimates. The cause of this is the correlation between instruments and the independent variables. The more information that the instrumental variable brings to the equation the less will be the variance. Although this technique does give higher variances than O.L.S., it should perform much better than O.L.S. in terms of consistency and bias.

A regression that is estimated, takes the form

$$Y = \beta_0 + \beta_1 X + e \tag{41}$$

Its estimator is derived using matrix algebra from

$$\beta = (X'X)^{-1}X'Y \tag{42}$$

where X is the matrix of independent variables and Y represents the matrix of the dependent variable.
But as the X and e are correlated in the classical test of bias in a futures market, we find and use a matrix of instrumental variables (Z) that is uncorrelated with the error term. The new estimator is derived from

$$\beta = (Z'X)^{-1}Z'Y \tag{43}$$

In this study, the closing price on the last day of trading of a contract was chosen as the measure of $SP_{(t+1)}$, the dependent variable matrix Y. Each of the fifty four

contracts, from January 1979 to September 1989, had 201 days of trading in this study. As the last or expiration day represented the spot price, 200 days of trading were left to represent FP_t or the independent variable matrix X. The two instrumental variables, the C.R.B. index and the soybean oil price, were matched to the independent variable matrix on a day to day basis, and then concatenated together to form the instrumental variable matrix Z.

As there are 200 observations in the X matrix and a corresponding number of rows in the Z matrix, one alternative would have been to estimate the regression using data for individual days prior to expiration, aggregating all of the contracts. This would have meant running 200 separate regressions. As this is excessive, monthly average price data were simulated by grouping daily price data for twenty concurrent trading days together. That is, the daily price data for the twenty days previous to expiration of each contract were grouped together and then averaged to depict one month of data, lagged one month prior to expiration. Daily price data for the independent variable as well as the instrumental variable matrix were similarly averaged. In applying the instrumental variable procedure, the regression equation was first estimated using the data from these averaged

periods for each futures contract as the X vector; the corresponding instrumental variable data averages are depicted as Z and the expiration price is taken as the Y vector in equation (43). There are then fifty four data points used as the independent variable, dependent variable and fifty four rows in the instrumental variable matrix.

The averaging procedure was then applied to the next previous twenty concurrent days prior to expiration of the contract, along with the instrumental variables, to simulate the month of data, two months prior to contract expiration. Again a regression was run using the same dependent variable, the expiration price, against this new simulated monthly average of futures price data and the new simulated month of the instrumental variables. This process was then repeated until all the 200 days of daily price data including futures prices and instrumental variables, were broken down into ten groups of twenty trading days. Each group was averaged together, to simulate lagged monthly price data, then using the instrumental variable technique regressed against the dependent variable, the closing price of each contract, to test the hypothesis of bias.

It can be pointed out that averaging the data in this manner will remove some of the variability in the futures

price and in the instrumental variables. This result could affect some of the results by increasing the strength of the postulated relationship.

The expectation is that for all of the resulting equations of

$$SP_{(t+1)} = \beta_0 + \beta_1 FP_t + u \qquad (40)$$

and at all lags of $FP_{(t)}$ prior to expiration, β_0 will equal zero and β_1 will equal one (with a positive sign).

A number of hypothesis were tested. The first test jointly tests the hypothesis that $\beta_1 = 1$ and $\beta_0 = 0$. The next two tests examined $\beta_1 = 1$ and $\beta_0 = 0$ individually. The expectation is that all three hypothesis tests should prove to be significant.

4.4 Data

The data used in this analysis were published time-series data collected from several sources. Fifty-four canola futures contracts, representing contracts expiring January 1979 to September 1989 inclusive, serve as the core data set of this study. This portion of the data were drawn from two sources; the first, which contributed the majority of the data, was from I.P. Sharp, the second from Knight Ridder Financial Information Services. The price used was expressed in dollars per metric tonne. The type of canola for this

contract is number one grade basis in Vancouver, Canada.

The soybean oil price was taken to be the price of a current or spot contract, that is, the nearby contract. The contract is given in cents per pound, number one grade, and deliverable in warehouses declared regular by the Chicago Board of Trade. This information was also retrieved from Knight Ridder Financial Information Services.

The C.R.B. index is, as previously stated, a compilation of 21 commodities. The source for this variable was Knight Ridder Financial Information Services.

Chapter 5

Results

5.1 Introduction

The results of this empirical study are presented in this chapter. In the first part the results of testing the random walk nature of the canola futures market using the matrix of log ratios (equation 27 above) are presented. The last part of the chapter presents the results of the instrumental variable technique used to test if the canola futures market is unbiased.

5.2 Log Ratio Approach

The results of applying a simple 't' test comparing the means to zero of the column averages of matrix (27) above were as expected. The 't' values range from .0060402 to 2.867. At the five percent level of significance the critical value is 1.97. Based on probability theory, the expectation is that ten values would be greater than the critical value by chance alone. The result in this study is that eleven values were greater than the critical value. The distribution over time is presented in Table 1 below. Eleven values is not statistically different from ten values. Therefore, using this test it would be concluded that the means of the columns of matrix (27) above do not individually differ from zero. The actual column averages and the associated 't' values are presented in Appendix B. The test suggests

that the changes in the future market prices from day to day over a large number of contracts are not different from zero. It is worth noting however that the largest number of significant values occurs in the time period closest to expiration, a time that traders are offsetting their contracts.

Table 1: Observed Number of Significant 't' Values When Column Averages of a Matrix of Logged Daily Price Changes of Canola Futures Contracts Expiring January 1979 to September 1989 are Compared to Zero.

LAG (days)	Number of significant 't' values
1-20	4
21-40	0
41-60	0
61-80	1
81-100	2
101-120	0
121-140	1
141-160	0
161-180	0
181-200	3

The second test of matrix (27) was to use a modified ANOVA to test simultaneously if all the column averages were different from zero. The calculated 'F' statistic was 1.0200803; the associated probability value is .592. This value of the probability of obtaining an 'F' statistic as numerically large or larger than 1.0200803 is .592. As this probability value is greater than the five percent level of significance, the null hypothesis cannot be rejected. If the null hypothesis had been rejected, indicating that the column averages which represent price changes do not equal zero, this would mean that the price changes are not random or stochastic.

The third and final test to determine if the futures price follows a random walk involved regressing the independent variable of days to expiry of a contract against the dependent variable of the column averages of matrix (27). If the equation or coefficients are significant, then drift on average of the contracts is being observed. The results of this regression are as follows:

$$\overline{LR}_{(t+m)} = .00001029 + -.00000182899M + u \qquad (44)$$

where the 't' statistic of the intercept term is .00302314, and for the slope coefficient it is -.0622391. The respective probability values are .998 and .950, R^2 = .0000196, and the overall 'F' statistic is .003874.

There are no expectations of the signs on the coefficients so they can be overlooked. The 'F' statistic has a value of .003874. The associated probability value is .95, thus at a 95% level of significance the null hypothesis is true, that the regression insignificant. This is in step with the expectation.

If the coefficients are examined, very low 't' statistics are found. The 't' statistic on β_0 probability value is .998 and the 't' statistic on β_1 probability value equals .950. That is, there is a 99.8% and 95% chance that β_0 and β_1 (respectively) are insignificant (or not different from zero). Also, the very low R squared value reinforces the expectation that there is no drift of prices on average as a futures contract approaches expiration.

5.3 Instrumental Variable Approach

If the futures market is unbiased, a resulting test regression is expressed as

$$SP_{(t+1)} = \beta_0 + \beta_1 FP_t + u \qquad (40)$$

The expectation is that $\beta_0 = 0$ and $\beta_1 = 1$. The first stage results of confronting this test of unbiasedness with real world data, using the instrumental variable regression technique, are presented in Table 2 below. In this table the intercept and slope coefficients are presented with the associated standard errors in

parentheses.

Table 2: Estimated Coefficients and Standard Error Results of Instrumental Variable Regression of Closing Canola Futures Contracts on Lagged Futures Prices of Contracts Expiring January 1979 to September 1989

	β_0 Intercept	β_1 Slope	R Squared
LAG (Days)↓			
1-20	20.199 (13.416)	.93678 (.040004)	.9320
21-40	-14.617 (27.571)	1.0514 (.083253)	.7918
41-60	20.269 (45.713)	.94490 (.13821)	.5220
61-80	32.720 (51.096)	.89973 (.15336)	.4546
81-100	62.112 (55.858)	.79492 (.16436)	.3554
101-120	42.208 (57.867)	.85689 (.17902)	.3350
121-140	80.785 (63.238)	.73818 (.18580)	.2261
141-160	84.630 (67.871)	.72633 (.19938)	.1760
161-180	85.149 (74.508)	.72305 (.21851)	.1242
181-200	101.34 (74.046)	.67183 (.21593)	.0553
Standard errors in parentheses			

The intercepts are expected to be zero. None of the intercept terms presented are actually zero and all but

one have positive signs. However, none of the intercept terms are significant; statistically they are not different from zero. This is consistent with expectations.

The expected value of the slope coefficients (β_1) is positive one. All of the resulting values have the expected positive sign. The values range from .67183 to 1.0514. As well, it can be noted that all of the slope coefficients are significantly different from zero at the five percent level of significance.

The next logical step was to test if $\beta_0 = 0$ and $\beta_1 = 1$. This hypothesis testing was first done jointly and then these two assumptions were tested independently. The results are presented in Table 3. The probability value results of the joint hypothesis range from .1590 to .6958 so the null hypothesis would be accepted at the five percent level of significance for all lags. When the hypothesis that $\beta_1 = 1$ is tested, the probability value results range from .1201 to .6918 so again the null hypothesis can be accepted. Thirdly, the intercept term was tested on its own to see if it was equal to zero. The probability value results range from .1086 to .6568 so we cannot reject the null hypothesis that the intercept

equals zero. These three hypothesis tests summarized in Table 3 provide results that would be expected if the canola futures market is unbiased.

As the information set grows as the expiry date nears, the R squared statistic goes up. This shows that the shorter the time period to expiration, the more accurate the futures price is in forecasting the spot prices.

Table 3: Results of Hypothesis Testing Using Instrumental Variable Regression of Closing Canola Futures Contracts on Lagged Futures Prices of Contracts Expiring January 1979 to September 1989

H_0: →	TESTING JOINT HYPOTHESIS $\beta_0 = 0$ $\beta_1 = 1$	TESTING $\beta_1 = 1$ ALONE	TESTING $\beta_0 = 0$ ALONE
LAG (Days)↓			
1-20	.25779593	.12006553	.10856606
21-40	.54354292	.53963124	.59826618
41-60	.69577039	.69177347	.65684757
61-80	.64357217	.51609587	.52474305
81-100	.24746736	.21770650	.27126488
101-120	.39106929	.40622954	.46902554
121-140	.21482789	.16475355	.20710132
141-160	.22277919	.17577669	.21800753
161-180	.23114427	.21062112	.25834429
181-200	.15898837	.13460472	.17699422
P (probability) value of H_0:*true*			

Chapter 6

Conclusions

6.1 Introduction

This chapter draws conclusions based on the results of this empirical study. The results will be summarized and related. As well, some of the implications of the results will be discussed. This study's shortcomings and possible rectification of these shortcomings will be examined. Lastly, improvements and extensions will be examined.

6.2 Summary to the Study

In this study the hypothesis that the canola futures market in Winnipeg is unbiased is confronted with real world data. This statistical study took a two-pronged approach to testing the hypothesis. The first method examined whether or not the futures market price follows a random walk. If the market did not follow a random walk, then a general drift, on average, or bias must be present. The second method of assessment used an instrumental variable regression analysis using futures prices as an independent variable and expiration prices as the dependent variable to check if the futures market is unbiased.

To check the random walk theory, three tests were used on a matrix of the daily price changes of fifty four futures contracts. From the results of each test, the hypothesis of random walk and unbiasedness had to be

accepted. In the second method, using an instrumental variable technique to overcome a problem of using Ordinary Least Squares, the hypothesis of unbiasedness was accepted at all lags tested. The results indicate that we cannot reject the hypothesis that the canola futures market is unbiased.

6.3 Implications

This conclusion has positive implications for the canola futures market and those trading on this futures market. The result that there is no bias suggests that these futures markets are well behaved or working well and that no one is at a disadvantage when using the futures market. For government and industry regulators this may imply that further intervention by government or industry is not required to improve the functioning of the futures market.

Hedgers and speculators may be interested in the results of this study. Because the canola futures market is unbiased, they can use the futures market to hedge without concern that they must pay undue premiums for this use. It appears that this market provides a viable marketing alternative for producers and an effective hedging tool for others such as millers or exporters.

The implications for economists are that the results of this study are consistent with those from the majority of studies which address the question of unbiasedness and

conclude that markets are unbiased. Other economists may be interested in this study since the methods applied overcome the shortcoming of testing for unbiasedness using simple Ordinary Least Square procedures. As well, the Rational Expectations school of economics can point to the result of this study in support of their theories that expectations today in the macro economy are self-fulfilling prophecies of the economy in the future.

6.4 Limitations

This study is not without some shortcomings. To completely examine the efficiency of the canola futures market, the test of the futures market which includes extra information (equation 20 above) should be included. In such a test, extra information is used to help futures prices to predict the spot price. If this extra information does not help predict the spot price, the market is efficient. If, however, the futures market forecast can be improved using this information, then the futures market price is not the best predictor of cash prices.

Another shortcoming lies in a technique used in examining the column averages of the log ratio price differences. This study used a 't' test in an attempt to prove the null hypothesis using a particular level of significance (α). A regular test attempts to disprove the null hypothesis, while the test used here was to prove

it. Perhaps a more appropriate method would be to use a 'power' test. The power test is concerned with the β or type II error. The β statistic is the probability of making a type II error, accepting the null hypothesis when it is actually false. The probability of making a correct rejection is $1-\beta$.

A third criticism which can be leveled against this study is that the tests of bias in the canola futures market cannot not tell how the markets are doing quantitatively. These tests cannot communicate an order of magnitude. That is, if a market passes the test, does this represent the fact that the market is performing as best it can? On the other hand if the market had failed these tests, how badly is the market functioning?

6.5 Alternative Methods

The statistical study reported here, using the methods presented, gave the results expected; however, alternate methods could be employed to check and reinforce the results of this study. One method that could be used is the Vector Auto Regressive method. This statistical technique involves selecting variables perceived as important to the variable the researcher is trying to predict. In the case of the canola market, soybean, soybean oil, soybean meal, exchange rates and exports could be a partial or complete list of the variables that would influence canola prices. Each value is represented

by the lagged values of any or all of the chosen variables. The deviation between how the system evolved and its expected evolution can be examined.

Another method of testing the hypothesis of unbiasedness would be to use Bayesian estimation. This could be a stand alone or a mixed estimation procedure which includes Bayesian and classical methods of statistics.

6.6 Concluding Statement.

In conclusion, the results of this study support the proposition that the canola futures market is unbiased.

Bibliography

Begg, D.K.H. (1982) The Rational Expectations Revolution in Macroeconomics Theories and Evidence, Baltimore U.S.A.: The John Hopkins University Press.

Berenson, M.L., D.M. Levine and M. Goldstein (1983) Intermediate Statistical Methods and Applications A Computer Package Approach, New Jersey: Prentice-Hall.

Bowerman, B.L. and R.T. O'Connell (1987) Time Series Forecasting Unified Concepts and Computer Implementation, 2nd. ed., Boston: Prindle, Weber & Schmidt.

Canadian Grains Industry, Various issues of Canadian Grains Industry Statistical Handbook , Winnipeg, Canada Grains Council.

Cohen, J. and P. Cohen (1983) Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences, 2nd. ed. Hillsdale U.S.A.: Lawrence Erlbaum.

Collins, B. (1986) An Empirical Analysis of Stock Index Futures Prices, Columbia University Center for the Study of Futures Markets, New York, Working Paper #135.

Commodity Research Bureau. Various issues of Yearbook.Chicago, Commodity Research Bureau.

Fama, E. F. "Efficient Capital Markets: A Review of Theory and Empirical Work." The Journal of Finance 25 (May 1970):383-417.

Fort, R.D. (1986) Commodity Futures Price Distribution and the Theory of Futures Trading, Columbia University Center for the Study of Futures Markets, New York, Working Paper #122.

Giles, David E.A and Goss, Barry A. "Futures Prices as Forecasts of Commodity Spot Prices: Live Cattle and Wool". The Australian Journal of Agricultural Economics Volume 25 No. 1, April 1981: 1-13

Gjolberg, O. and T.Johnsen (1986) The Performance of the Nymex Energy Futures Trade, Columbia University Center for the Study of Futures Markets, New York, Working Paper #142.

Godfrey, L.G. (1988) Misspecification Tests in Econometrics, NewYork: Cambridge University Press.

Gordon, J.D. (1985) The Distribution of Daily Changes in Commodity Futures Prices, United States Department of Agrculture, Economic Research Service, Washington, Technical Bulletin Number 1702.

Gray, R.W. "The Search for a Risk Premium" The Journal of Political Economy 69 (June 1961): 250-260.

Gujarati, D. (1978) Basic Econometrics, New York: McGraw-Hill.

Harris R.J. (1975) A Primer of Multivariate Statistics, New York: Academic Press.

Harvey, A.C. (1981) Time Series Models, Allan, Oxford.

Hodrick, R.J. (1987) The Empirical Evidence on the Efficiency of Foward and Futures Foreign Exchange Markets, Chur Switzerland: Harwood Academic.

Hudson, M.A., R.M. Leuthold and G.F. Sarassorro (1986) Commodity Futures Price Changes: Distribution, Market Efficincy, and Pricing Commodity Options, Columbia University Center for the Study of Futures Markets, New York, Working Paper #127.

Jacob, N.L., and R.R.Pettit (1984) Investments, Homewood, Illinois: Richard D. Irwin Inc.

Judge, G.G., W.E. Griffiths, R.C. Hill, H. Lutkepohl and T.C.Lee (1982) Introduction of the Theory and Practice of Econometrics, New York: John Wiley.

Judge, G.G., W.E. Griffiths, R.C. Hill, H. Lutkepohl and T.C.Lee (1985) The Theory and Practice of Econometrics 2nd ed., New York: John Wiley.

Kahl, K.H. And Tomek, W.G. "Forward-pricing Models for Futures Markets: Some Statistical And Interpretative Issues." Food Research Institute Studies, Vo. XX, No. 1, 1986.

Kennedy, P. (1985) A Guide to Econometrics, 2nd ed., Cambridge: The MIT Press.

Keynes, J.M. "Some aspects of Commodity Markets." The Manchester Guardian Commercial, Reconstruction Supplement, 29 March, 1923 reprinted in Vol. X11 of The

Collected Writings of John Maynard Keynes. London: The MacMillan Press Ltd. for the Royal Economic Society. 1983: 255-266.

Kirk, R.E. (1982) Experimental Design: Procedures for the Behavioral Sciences, Belmont California: Brooks/Cole.

Kolb, R.W. and R.S. Hamada. (1988) Understanding Futures Markets, 2 ed., Boston: Scott, Foresman and Company.

Koutsoyiannis A. (1977) Theory of Econometrics 2nd. ed., London: MacMillan.

LeRoy, S.F. "Efficient Capital Markets and Martingales." Journal of Economic Literature. 27(Dec. 1989): 1583-1621.

Leuthold, R. M. "The Price Performance on the Futures Market of a Nonstorable Commodity: Live Beef Cattle." Amer. J. Agr. Econ. 55(1974): 271-79.

Longworth, D., P. Boothe, and K. Clinton (1983) A Study of the Efficiency of the Foregn Exchange Market, Ottawa, Canada: Bank of Canada.

Malinvaud, E. (1980) Statistical Methods of Econometrics, 3rd. ed., Amsterdam: North-Holland.

Malkiel, B.G. (1985) A Random Walk Down Wall Street, 4 ed., New York: W.W.Norton.

Martin, L. And P. Garcia "The Price-Forecasting Performance of Futures Markets for Live Cattle and Hogs: A Disaggregated Analysis." Amer. J. Agr. Econ. May 1981: 209-215.

Mason, R.D. (1982) Statistical Techniques In Business and Economics, 5th. ed., Homewood, Illinois: R.D.Irwin.

Miller, R.G. (Jr.) (1981) Simultanous Statistical Inference, 2nd. ed., New York: Springer-Verlag.

Minford, P. and D.Peel (1986) Rational Expectations and the New Macroeconomics, New York: Basil Blackwell.

Mishkin, F.S. (1983) A Rational Expectations Approach to Macroeconometrics Testing Policy Ineffectiveness and Efficient-Markets Models, Chicago: University of Chicago Press.

Morrison, D.F. (1976) Multivariate Statistical Methods, New York: McGraw-Hill.

Pesaran, M.H. (1989) The Limits to Rational Expectations, New York: Basil Blackwell.

Pindyck, R.S. and D.L. Rubinfeld (1981) Econometric Models and Economic Forecasts, 2nd. ed., New York: McGraw-Hill.

Sarkdi, K. and I. Vincze (1974) Methods of Statistical Quality Control, New York: Academic Press.

Stein, J.L. (1986) The Economics of Futures Markets, New York: Basil Blackwell Inc.

Thomas, R.L. (1985) Introductory Econometrics: Theory and Applications, London: Longman.

Thomopoulos, N.K. (1980) Applied Forecasting Methods, New Jersey: Prentice-Hall.

Tomek, W.G. and R.W.Gray "Temporal Relationships Among Prices on Commodity Futures Markets: Their Allocative and Stabilizing Roles." Amer. J. Agr. Econ. 52(1970): 372-380.

Veeman M.M., R.E. Burden, X.Y. Dong, (1988) Final Report to Farming For the Future Council on Performance of the Rapeseed Futures Market, ARCA Project 84-0339, Edmonton: University of Alberta:

Walraven, N.A. and G.C. Rausser (1986) Empirical Pricing Efficiency Measures for Futures Markets, Columbia University Center for the Study of Futures Markets, New York, Working Paper #143.

Working, H. "The Theory of Price of Storage." American Economic Review, 39 (December 1949): 1254-1262.

Appendix A

The focus of this appendix is to show the validity of the modified 'F' test first described in Chapter 4, Section 2 above. As previously stated this test is a modified analysis of variance (ANOVA) test. The method presented below originates in Sarkadi and Vincze (1974, Methods of Statistical Quality Control, page 176).

To show the validity of this modified F test a regular ANOVA will be examined. The null hypothesis is

$$H_0 \; : \quad \overline{X}^{(i)} = \overline{\overline{X}} \qquad (i = 1,2,3,\ldots,n)$$

The test statistic is

$$F = \frac{MS_{bg}}{MS_{ug}}$$

where the calculated 'F' statistic is equal to the mean square between groups (or columns) divided by mean square within the groups themselves.

Where

$$MS_{bg} = \frac{m \sum_{i=1}^{k} (\overline{x} - \overline{\overline{X}})^2}{k-1}$$

and

m is the number in each column in the sample

$\overline{x}$ is that column average

$\overline{\overline{X}}$ is the grand mean to be compared against and

k is the number of columns

and

$$MS_{wg} = \frac{\sum_{i=1}^{k}\sum_{j=1}^{m}(x - \bar{x}^{(i)})}{mk - k}$$

By examining the numerator and the $(\bar{x} - \bar{\bar{x}})$ it can be shown that the farther the means are away from the grand mean, the greater is the value in the numerator and therefore the greater the 'F' statistic value. This result would push the calculated value farther to the right in an 'F' distribution toward the tail of rejection, and depending on the level of significance, the researcher might reject the null.

If, however, we replace the grand mean $\bar{\bar{x}}$ with a constant C the effect is essentially identical. The greater the difference between the means and the chosen constant the greater will be the 'F' statistic.

This will be demonstrated using the data from the table below. The table shows hypothetical data of four different treatments with ten observations in each treatment.

Table 4: Hypothetical Data of Four Treatments Used to Prove the Modified ANOVA

	$X^{(1)}$	$X^{(2)}$	$X^{(3)}$	$X^{(4)}$
1	28	30	31	29
2	26	29	29	27
3	29	30	33	30
4	30	30	33	31
5	28	28	29	27
6	31	32	33	32
7	26	29	28	27
8	32	32	32	32
9	25	28	27	27
10	29	30	32	30
$\overline{X}^{(i)}$	28.4	29.8	30.7	29.2

The grand mean is $\overline{\overline{X}} = 29.525$.

The null hypothesis is

$$H_0 : \quad \overline{X}^{(i)} = \overline{\overline{X}} \qquad (i = 1,2,3,4)$$

The significance level is five percent ($\alpha = .05$).

Where the test statistic is

$$F = \frac{MS_{bg}}{MS_{wg}}$$

where

$$MS_{bg} = \frac{m \sum_{i=1}^{k} (\bar{x} - \bar{\bar{X}})^2}{k-1}$$

and

$$MS_{wg} = \frac{\sum_{i=1}^{k} \sum_{i=1}^{m} (x - \bar{x}^{(i)})}{mk-k}$$

The degrees of freedom in the numerator of the 'F' statistic is k-1 and in the denominator is mk-k. In this case k=4 and m=10. The critical value is 2.86.

Using the above data, MS_{bg} equals 9.425 and MS_{wg} equals 4.158. Therefore,

$$F = \frac{9.425}{4.158}$$

The calculated value equals 2.27. As this value is less than our critical value, we can accept the null hypothesis. The mean values at different levels are equal to 29.525.

If in the example the grand mean in the numerator is replaced with a constant that is larger than the grand mean, the results are as follows. (Just as easily the constant could be smaller than the grand mean and the result would be the same.)

The null hypothesis becomes

$$H_0 : \quad X^{(i)} = C \qquad (C = 30.5)$$

And the calculated test statistic remains

$$F = \frac{MS_{bg}}{MS_{wg}}$$

But now in the numerator we replace $\bar{\bar{X}}$ with C a constant. The numerator value is now 22.1. The calculated 'F' statistic now is 5.315. The researcher would now reject the null hypothesis that the means are equal to 30.5.

Appendix B

The table below represents the results of calculating the column averages of the log ratio matrix (equation 27). Column 1 are the number of days to expiration, column 2 are the actual column averages and column 3 gives the associated 't' statistic value.

Table 5: Results of Column Averages of Logged Daily Price Changes of Canola Futures Prices of Contracts Expiring January 1979 to September 1989, Means and Caculated 't' Statistics

200	-0.000603073	0.0313005
199	0.0006813187	0.552785
198	-0.0007935139	0.715944
197	-0.0000288157	0.115856
196	-0.0011987282	0.93383
195	0.0005967543	0.0578812
194	0.0013631913	0.917813
193	-0.0005409406	0.0235233
192	-0.0000780211	0.0936398
191	-0.0007526946	0.173259
190	0.0026555567	2.04532
189	-0.0003989033	0.00604227
188	-0.0005668284	0.0144617
187	0.0027720324	2.05592
186	-0.004272292	2.867
185	-0.0006873471	0.100874
184	-0.0017137117	1.51206
183	-0.0014468157	1.58966
182	-0.0002918799	0.154774
181	0.0013665953	0.707759
180	-0.0009762991	0.374482
179	0.0008521864	0.23751
178	-0.001151841	0.931305
177	0.0007564738	0.0664886
176	0.0025829354	1.32918
175	-0.000109783	0.319317
174	0.0017238328	0.771207
173	-0.0008258424	0.400966
172	-0.0010230831	0.557497
171	0.0012797381	1.0525
170	-0.061471278	0.9596
169	0.061711694	0.937581
168	0.0008925844	0.252763
167	-0.0019506773	1.56028
166	-0.0024241352	1.37143

165	-0.0015682675	1.22215
164	-0.0000612999	0.315739
163	-0.0029131075	1.34785
162	-0.001451127	0.168929
161	-0.0000062345	0.43023
160	0.0001984126	0.419011
159	0.0008184019	0.947615
158	0.0020342009	1.72619
157	0.0005253835	1.02045
156	-0.000110718	0.273688
155	-0.0017765659	1.49361
154	0.0024903706	1.11255
153	-0.001341147	1.28389
152	0.0012837109	0.470646
151	0.0000848692	0.297226
150	-0.0004216206	0.418566
149	0.0003035342	0.610706
148	-0.039148179	0.94849
147	0.037046454	0.950677
146	0.0014797448	1.1664
145	-0.0008959359	0.326387
144	0.0006285374	0.668992
143	-0.0024986037	1.60341
142	-0.0022791647	1.0679
141	-0.0006450051	1.03275
140	0.0008909494	0.469161
139	-0.0004062632	0.415587
138	-0.0007714318	0.108984
137	0.0017980137	0.882264
136	0.0013717528	0.583891
135	0.0025514368	1.58832
134	0.0006712751	0.290526
133	0.0025475432	0.809494
132	-0.0031628008	2.33897
131	-0.045280305	0.942151
130	0.046796753	0.998871
129	0.0011417008	0.781225
128	0.000872892	0.104022
127	0.0011664829	0.142806
126	0.0029041179	1.2204
125	-0.0018605592	1.37326
124	-0.050256258	1.04692
123	0.044869716	0.911203
122	-0.045855029	1.00932
121	0.0006451485	0.0623025
120	0.042719921	0.937672
119	-0.0021368788	1.07713
118	0.0014500735	1.24419
117	0.0008484425	0.864654
116	0.0008762168	0.862804
115	-0.037895081	0.953619
114	-0.0032456878	1.8047

113	0.040249835	0.964775
112	-0.0000072261	0.334964
111	-0.0003797622	0.896279
110	0.0007833848	0.40879
109	0.0012656549	1.14674
108	0.0018300257	0.586188
107	-0.0000434823	0.516072
106	-0.0013751233	0.597495
105	0.000420983	0.259724
104	-0.0001469564	0.867805
103	-0.0007087022	0.867168
102	0.000816479	0.64115
101	-0.0011325707	0.735863
100	-0.0003268303	0.044645
99	-0.0024736285	1.36062
98	-0.0000678605	0.445224
97	0.0031513581	2.28197
96	0.0001479931	0.154414
95	0.003819537	2.1425
94	0.0009276175	0.645296
93	-0.0002802735	0.14327
92	0.0021093123	1.23386
91	-0.0022228123	1.62927
90	-0.041890681	0.903318
89	0.047181119	1.00333
88	0.000009719	0.461215
87	-0.0032691582	1.63312
86	-0.0016644776	1.27551
85	0.0020398346	0.756339
84	-0.0009452393	0.210815
83	-0.032701972	1.02045
82	0.027745586	0.85633
81	-0.035373689	1.00759
80	-0.0027410341	1.5074
79	0.031615037	0.908236
78	-0.037288207	0.985754
77	0.036552161	0.967155
76	-0.032548456	0.954823
75	0.033192721	1.00037
74	-0.072130748	1.36261
73	0.035985222	0.556811
72	-0.020490614	0.319829
71	-0.0015036711	1.3053
70	0.052570023	0.956358
69	-0.0009649045	0.6763
68	-0.04135598	0.922157
67	0.045115827	1.02336
66	0.0015209453	0.841545
65	0.0012095341	1.03335
64	-0.0002359176	0.108131
63	-0.0031482005	2.02074
62	-0.040650734	0.962196

61	0.0027182946	0.0357714
60	-0.015285418	0.22895
59	-0.03845107	0.981608
58	0.087921833	1.31106
57	-0.039617548	1.009
56	-0.040795211	0.553[illegible]06
55	0.082583941	1.40893
54	-0.0003940175	0.334163
53	-0.041416551	0.921537
52	0.043632573	0.950671
51	-0.034693176	0.943184
50	0.035737083	0.95956
49	-0.080833442	1.3328
48	0.084118321	1.38896
47	-0.034696277	0.96382
46	-0.0004499102	0.0397645
45	0.030478921	0.787812
44	-0.037136647	0.99504
43	-0.011525598	0.18364
42	0.0078385276	0.128609
41	0.038695987	0.954089
40	-0.0031042353	1.63236
39	-0.0024723152	1.49442
38	-0.038385079	0.8993
37	-0.086710825	1.34826
36	0.12666159	1.67194
35	0.0000288404	0.140881
34	0.0012889431	0.540626
33	-0.0008342624	0.274266
32	-0.0004625626	0.0930938
31	0.0001403294	0.0495809
30	0.0003972578	0.244778
29	-0.044631167	0.931495
28	0.042746271	0.937546
27	-0.0018820429	1.73527
26	0.0018847486	0.967282
25	-0.052981772	0.9743
24	0.0097499957	0.136406
23	0.043654526	0.99705
22	-0.0010965939	0.624788
21	0.0009829018	0.572845
20	-0.0005442057	0.046916
19	-0.0007819263	0.773712
18	-0.0035289165	2.30458
17	-0.0016135331	1.19291
16	-0.0022168455	1.37587
15	-0.0005607085	0.194163
14	0.0008791327	0.700352
13	0.0032024349	2.46335
12	0.004578716	2.59547
11	0.0047329701	2.57521
10	0.0023237214	1.12269

9	-0.0028425632	1.00443
8	0.0042746845	0.937647
7	-0.001835975	0.937698
6	0.0016894403	1.07835
5	-0.0017135603	0.858106
4	-0.0020611628	0.980183
3	-0.0031339466	1.44982
2	0.0021804274	1.15792
1	-0.0010416824	0.499889

Appendix C

The Commodity Research Bureau (C.R.B.) index used, was the futures index, which includes the following commodities:

Cattle (Live)

Cocoa

Coffee

Copper

Corn

Cotton

Crude Oil

Gold (New York)

Heating Oil (No. 2)

Hogs

Oats (Chicago)

Lumber

Orange Juice

Platinum

Pork Bel'ies

Silver (New York)

Soybeans

Soybean Meal

Soybean Oil

Sugar "11" (World)

Wheat (Chicago)